# CLAIMS

What is claimed is:

1. An apparatus for microwave radio frequency communication wherein an upstream radio frequency (RF) band is used for transmitting signals in an upstream direction, and a downstream radio frequency band is used for receiving signals in a downstream direction, the apparatus comprising:

an up-converter comprising at least two up-converter stages, each up-converter stage including a mixer, and each mixer accepting a respective local oscillator signal wherein a final up-converter stage is connected to provide a transmit RF upstream signal;

a down-converter, comprising at least two down-converter stages, each down-converter stage including a mixer and accepting a respective local oscillator signal wherein a first down-converter stage is connected to receive a receive RF downstream signal;

the mixers in the first down-converter stage and the final up-converter stage being connected to receive a common local oscillator signal;

a local reference oscillator, for providing a local reference signal;

a first frequency multiplier circuit, connected to receive the local reference signal, and to provide the common local oscillator signal at a frequency which is an integer multiple of the local reference signal; and

wherein the local reference signal is also to derive the local oscillator signal coupled to one of the mixers in a down-converter stage which is not the first down-converter stage, or the local reference signal is used to derive the local oscillator signal coupled to one of the mixers in an up-converter stage which is not the final up-converter stage.

2. An apparatus as in claim 1 wherein the local reference signal is fed to a second frequency-multiplier circuit to provide the local oscillator signal coupled to the mixer in the final down-converter stage.

3. An apparatus as in claim 2 wherein the multiplication factor of the second frequency multiplier circuit is four.

4. An apparatus as in claim 1 wherein the down-converter stages shift a carrier frequency of the microwave RF downstream signal by a factor of 10 times the local reference.

5. An apparatus as in claim 1 wherein the up-converter shifts a carrier frequency of the microwave RF upstream signal by a factor of 10 times the local reference.

6. An apparatus as in claim 1 wherein the first frequency multiplier circuit includes a series pair of frequency doubler circuits.

7. An apparatus as in claim 1 additionally comprising:

a second reference local oscillator, coupled to provide the local oscillator signal to one of the mixers in an up-converter stage which is not the final up-converter stage, or coupled to provide the local oscillator signal to the mixer in a down-converter stage which is not the first down-converter stage, the frequency of the second local reference oscillator being selected to separate the upstream and modem downstream signals by a desired guard band.

8. An apparatus as in claim 1 wherein an upstream RF band and a downstream RF band are contiguous in frequency.

Sub a2

9. An apparatus as in claim 1 wherein an upstream RF band and a downstream RF band are separated in frequency.

10. An apparatus as in claim 1 wherein the transmit RF upstream signal and the receive RF downstream signal are coupled to an antenna.

10 9

11. An apparatus as in claim 10 wherein an ortho mode transducer (OMT) couples the transmit RF upstream and receive RF downstream signals to the antenna.

Sub a3

12. An apparatus as in claim 1 additionally comprising

a modem, for coupling a modem upstream signal to the first up-converter stage, and for coupling a modem downstream signal to a final downconverter stage.

12

13. An apparatus for microwave radio frequency communications comprising:

a duplexer, coupled to a cable to receive a digitally modulated upstream signal from, and to provide a digitally modulated downstream signal to the cable, the upstream signal containing information in a cable modem upstream frequency band, and the downstream signal containing information in a cable modem downstream frequency band;

a first up-converter stage, coupled to receive the upstream signal from the duplexer and to receive a first intermediate frequency (IF) reference signal, the first up-converter stage additionally including a local reference oscillator, a frequency doubler, and a mixer, the frequency doubler connected to receive an output of the local reference oscillator and to provide the first IF reference signal, and the mixer for combining the first IF reference signal and the upstream signal from the duplexer;

a second up-converter stage, coupled to receive the output of the first up-converter stage, the second up-converter stage including a mixer also

receiving a second IF reference signal, the second IF reference signal derived from the first IF reference signal used in the first up-converter stage, but being first processed through a pair of cascaded frequency doubler circuits, the second up-converter stage thus providing an output up-converted signal;

a transducer coupled to receive the output of the second up-converter stage, and to provide an up-converted signal to a microwave antenna, and also coupled to receive a signal from the microwave antenna, and to provide it to at a transducer output port;

a first down-converter stage, coupled to receive the signal from the transducer output port in a first microwave RF range, the first down-converter stage having a mixer which uses a reference signal which is the same second IF reference signal used by the mixer of the second up-converter stage; and

a second down-converter stage coupled to receive the output of the first down-converter stage, the second down-converter stage also including a mixer connected to receive a third IF reference signal and to provide a downconverted output signal in a cable modem downstream band, and to couple the downconverted signal to an input port of the duplexer.

13

14. An apparatus for microwave radio frequency communications comprising:

a duplexer coupled to a wired physical transport media to receive an upstream signal from and to provide a downstream signal to the physical media, the upstream signal containing information in a cable modem upstream frequency band, and the downstream signal containing information in a cable modem downstream frequency band;

a first up-converter stage, coupled to receive the upstream signal from the duplexer, the first up-converter stage including a mixer that receives a first intermediate frequency (IF) reference signal and provides a first up-converter stage output signal;

a second up-converter stage, the second up-converter stage containing a mixer which receives the output of the first up-converter stage and a second IF reference signal, and provides a second up-converter output signal;

an ortho-mode transducer connected to receive the up-converter output signal, and to couple it to a microwave radio antenna, the ortho-mode transducer also connected to receive a signal from the microwave antenna and to provide it at an ortho-mode transducer output port;

a first downcoverter stage, connected to receive the signal from the ortho-mode transducer output port, the first down-converter stage comprises a mixer, accepting as input the second IF reference signal;

a second down-converter stage comprising a mixer and a local reference oscillator, the local reference oscillator connected to a frequency doubler to provide a third IF reference signal to the mixer in the second down-converter stage;

a pair of cascaded frequency doublers, connected to receive the third IF reference signal and to output the second IF reference signal for the first down-converter stage and the second up-converter stage; and

whereby the output of the second down-converter stage is connected to an input of the duplexer to provide the downstream signal in a cable modem downstream frequency band.